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The Impact of R&D Expenditures on Development: A Case of Turkey

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ABSTRACT: *R&D (Research and Development) expenditure is an important factor for the competitive strength and economic development of a country. R&D activities influence development through many channels such as innovation, accumulation of capital, and development in human capital. R&D expenditures are the main driving force for economic growth with innovations that they have created. Today's economies are faced with intense competition. This is not only the competition that globalization brings along but also the result of the development in the field of knowledge and technology. This new competition has required greater emphasis on R&D activities. R&D investments significantly affect the development level of a country. Development levels of countries are measured by the size of the resources they allocate to R&D expenditures. Turkey has dramatically increased its R&D and innovation-oriented work in the process of economic transformation it went through 2000's, and as a reflection of that, it has made progress in terms of both financial and human capital in the sources directed to works. In this study, the relationship between R&D expenditures and human development index for Turkey was analysed with the help of regression model; it was determined that HDI variable will increase by 6% if the R&D variable increased by 1%. The positive statistically significant effect of R&D variable on development was obtained.*

Keywords: *R&D Expenditures, Development, Regression Analysis*

I. INTRODUCTION

Technological developments in industrialized countries are one of the most important determinants of long-term economic growth and development. Technological developments emerge as the result of R&D activities performed by companies. As technological innovations increase a company's market share by enhancing its competitiveness, it also contributes to the improvement of its profitability. It is also another fact that technological innovations provide efficient use of resources by providing effectiveness in production. Looking from a macro point of view, technological developments act as an important factor in development and increasing the quality of life, by accelerating economic growth (Griliches, 1984). R&D expenditures are one of the most important variables used to describe the technology capability of a country or company. Processes such as the development of a new product or production method through R&D, effective use, adaptation or replacement of existing technology are very important at every stage of technological activities (Habiyaremye and Raymond, 2013). Innovation is important for the economic decision-making units of a country; in addition to this, it also directs the economic policies. The way of being able to innovate and to include these innovations into the production process is through the national research and development activities. The innovations emerging as the result of these activities enable companies to extend their markets by contributing their competitive power; in addition, cause increase in their profitability levels. Technological advances will lead to specialization in production by providing efficient use of resources. That will play an important role in increasing the welfare level and accelerating the development, by expediting the growth of the national economies (Ulku, 2007). Turkey has made remarkable progress with regards to human and financial resources in the last decade. Investments in R&D and innovation and the outputs obtained therefrom need to be carried to even further dimensions. In accordance with this purpose, it is important that the strategic transformation to be realized should be shaped by the mechanisms oriented to obtain feasible results, especially education and economy. Therefore, aside from rising the resources directed at R&D for the targeted economic transformation, importance should be attached to that the relevant projects are result-oriented, coordination between relevant institutions and organizations is provided for the effectiveness of the works. In other words, the subject of conducting "integrated R&D studies" should form the basis of the strategy. For Turkey to achieve the scientific and technological development that constitutes the basis of the new economy that it targets to reach in the middle and long term, may only be possible through a paradigm shift in that axis. The aim of this study is to determine the relationship between R&D expenditures and development for Turkey in the period of 1998-2015. The results obtained with the help of the regression model have been interpreted and suggestions offered.

II. THE IMPORTANCE OF R&D ACTIVITIES IN THE DEVELOPMENT PROCESS

2.1. The Scope of R&D Activities

Technological change and R&D activities are the important determinants of economic boost and development-based productivity growth. R&D is systematic and creative work aimed at discovering new products and production processes. It is regarded as an important source for making out new products, new production techniques, new information and new processes. According to the OECD (2002) report, R&D includes creative work that increases information stock and uses this stock to design new applications and discoveries. R&D is a factor that affects the productivity levels of companies. The information stock obtained as the result of R&D works play a key role in the production of competitive products, and also significantly affects the profitability levels of the company. R&D is not only a source of new technologies but it also significantly contributes to the activities that have an important place in the formation of new technologies such as learning by practicing or design in the industrial economies in the modern world.

R&D activities consist of regular creative works performed to enhance the knowledge accumulation, including knowledge of society, culture, and people, and to use it in new applications. In the narrow sense, R&D is the whole of systematic and creative works for discovering and introducing new products and production processes in enterprises (Wang et al., 2013). According to another definition, R&D activity is regular work in order to obtain new information that will enable the development of science and technology or to produce new materials, products or tools with existing information, to create new systems, processes, and services including software production or to develop existing ones (Inekwe, 2014). The information obtained as a result of R&D activities is used to develop a new product and production method and to uncover a new market. This information generated contributes to the development of companies by increasing their competitiveness. The information produced at a company quickly spreads to other companies in the region by means of technology and network systems and contributes to the development of the region as well (Sadraoui et al., 2014).

R&D activities can be defined as activities that are carried out benefiting from the human capital and existing stock of information and the outputs of which bear original, scientific and technical content, with the objective to develop new products, services, and processes and to meet the needs of the economy introducing these to the market (Pessoa, 2010; Gerybadze, 2010). It is known that countries that want to keep pace with the dynamic global development which is continuing rapidly, have especially concentrated on the R&D concept over the last few decades. The main reason behind this tendency is the fact that nowadays, R&D is the most important force for competitiveness and sustainable economic growth and development (Peng, 2010).

R&D contains creative works that increase the knowledge stock, uses this knowledge for the new applications, and is based on a systematic basis. R&D covers three activities: basic research, applied research and experimental development. Basic research includes theoretical and experimental work performed to acquire new knowledge. Applied research, involves specific research conducted in order to acquire new knowledge and the research here is directed towards specific practical aims or objectives. Experimental development is a systematic work and an activity in which knowledge is gained from research and practical experience. These activities are structured to produce new materials, new products or devices, to develop new production methods or systems or to take those generated and developed processes much further. The share of R&D expenditures in GDP is used in international comparisons. R&D expenditures consist of total R&D expenditures that are made by domestic companies, research institutes, government laboratories, universities, and so on (OECD, 2016).

2.2. The Driving Impact of R&D Activities on the Development

Development is the act of creating a society or communities: here, everyone can easily access basic rights and health, justice, security, employment and education services and information resources; market conditions function justly; management structures are participatory, gender balanced, open to democratic and cultural transformations, transparent/accountable; all the disadvantaged groups and classes disappear in the social sense; there is improved problem-solving skills; natural resources are protected and developed; people look to the future with confidence (Fagerberg et al., 2009). Woolcock and Narayan (2000) in their study, state that countries must pass through various stages before completing their development processes, and refer to that development has five stages. These stages are respectively; traditional society, preconditions or the preparatory stage, the "take-off" stage, drive to maturity, and the stage of mass consumption. The stage of maturity is characterized by large-scale investments. Economic and technical progresses positively affect this stage.

R&D provides the production of new information and technologies. New technologies emerging as the result of R&D activities increase the efficiency and leads to the economic growth. In other words, R&D leads to innovation, and innovation leads to productivity growth. Thus more R&D will lead to more innovation and more innovation will result in increased productivity (Coe and Helpman, 1995). R&D produces technology which is a form of information used to increase the effectiveness of the production factors in order to stimulate economic growth, address social problems such as the environment and health, and ultimately improve the living standards. The ability of the countries to commercialize this information through R&D investment to create new

knowledge and ensure economic value is of great importance for enhancing technological advance, productivity, wealth, and quality of life (Mohnen, 1996).

Throughout the history of the mankind, many important ideas have had to undergo long periods of ripening before they can be used in industries that produce better goods. Uncertainties and the costs of maturation often cause the investment expenditures for R&D and knowledge to be less than the optimal. A successful R&D requires continuous and long-term work, and in this sense, countries that understood its importance earlier have now become countries that produce technology (Bilbao and Rodríguez, 2004). In addition to the investment and R&D activities, another criterion showing the technology capability of a country or company is the number of the patents received by that country or company. While R&D expenditures are an input for the technological innovation activities, the number of patents received is a result of these technological innovation activities. In addition, R&D activities are not intended just for technological innovation but also cover the better use, adaptation, and training of the existing and imported technology. Therefore, it can be said that there is a strong positive relationship between R&D activities and patent numbers rather than a one-to-one relationship (Becker, 2014).

Economic development is a process which means both quantitative and qualitative improvement in all economic indicators. This process includes productivity growth in the industry and agriculture, increasing reduction of the external dependency, equality of opportunity in the service industry, and urbanization. While the investments related to infrastructure continue to be completed on course to the development, an increase in the national income is observed as well. As life standards improve, opportunities for savings and investment will also increase. The task of the entrepreneurs in this process is to increase the volume of production by transferring the savings into investments, within the rotating wheel. Using the types of innovation, the entrepreneur ensures the formation of the companies that have the capacity to compete with each other (Zachariadis, 2004). A company is one of the decision-making mechanisms in the capitalist system. The company's business is completely determined by the attempts of the person with an entrepreneurial spirit or by the partnerships. For the institutionalization of the companies, division of labour is a mandatory condition. The survival of an institutionalized company depends on practically applying the innovation techniques. Therefore, with the employment and production that it provides, it will have an active role in the development of the society (Falk, 2006). It is also necessary for countries to focus their attention on some key points in terms of ensuring their growth and economic development. These are: to emphasize policy development in increasing the use of new technology; to increase competition by implementing regulatory reforms in the telecommunications industry in order to expand the use of information and communication technologies; to ensure adequate competition in software and hardware systems in terms of reducing costs; to provide reliability in the use of information and communication technologies for both business life and consumers; and finally, as the most important point, to make the e-government a priority (Jaumotte and Pain, 2005).

Various differences are observed in the development of developed or developing countries. The reason for the development differences are the factors such as the shortage of natural resources, rapid population growth, the inadequacy of investments, the distance to energy resources, inability to complete industrialization. The presence of these factors causes people to live in different standards. While some live at the poverty line, others have a high quality of life. Many national and international organizations are working and developing projects in order to reduce these differences in the world. The aim is to reduce the problems which are brought by the differences (Grossman and Helpman, 1991).It is seen that only through due consideration of the both R&D and innovation activities, it is possible for the countries to compete economically and to maintain their power. The countries that are advanced in terms of technology are considered as developed countries. Furthermore, the greater the advances made in the field of technology, the greater the economic growth (Nelson and Rosenberg, 1993). Developing countries have constantly been in search of raising the levels of their economic welfare. Nevertheless, the differences applied in those searches have revealed themselves in the levels of development. R&D has become a concept that defines the development levels of societies.

R&D activities are more prevalently seen in the industrialized countries. Communication and information technologies constitute the main source of the radical changes that occur in the economic structures of these countries. The change in this field is spreading rapidly all over the world. The changes in both the economic and the political arena cause that the roles in the market change, and at the same time that all world values get closer together on a social and cultural basis (Becker, 2014; Bor et al., 2012). Rapid transposition of technology and capital as the result of the recent developments presents a variety of opportunities for the states that we call the emerging economies. The indicators of innovation and R&D expenditures are important in the growth and development of the emerging economies. Nowadays, the importance of the development process by using R&D and innovation gradually increase. Significant progress has been achieved both in the world and in Turkey thanks to the public incentives given in R&D and innovation. The importance of technological innovation and R&D activities to achieve economic development is enormous and has positive consequences for the national economy (Fagerberg, 2002).

III. THE OVERVIEW OF R&D EXPENDITURES IN TURKEY

R&D expenditures in Turkey have continually shown increase since 2002. The increase was the highest between 2006 and 2007, with an amount of TL 1,770 million. R&D expenditures have increased by nearly three times in 2009 compared to 2002 and reached TL 8,492 million in 2009. Between 2002 and 2009, in Turkey, there has been a steady increase in the share of R&D expenditures in the GDP. However, R&D expenditures have not reached to adequate levels, although significant increases have occurred in recent years. At this point, it is seen to be far below the R&D expenditure rate of the European Union. According to TURKSTAT data, the share of R&D expenditures in GDP is 1.06% as of 2015, whereas this ratio is 4.02% on average in the EU that comprises 27 member states. The ratio of R&D expenditures to GDP reached its highest level in 2015.

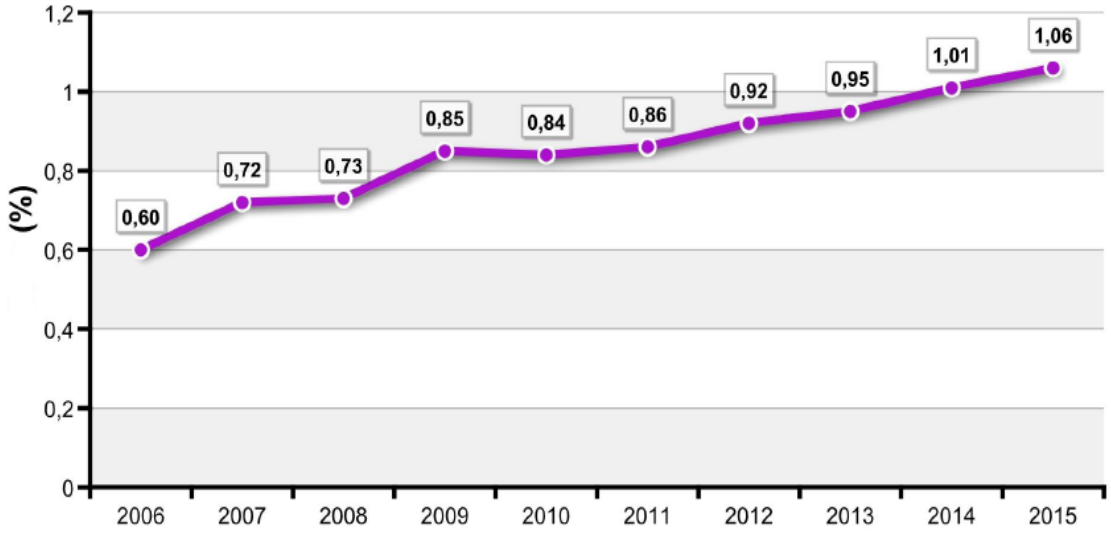

Figure 1: Ratio of R&D Expenditures to GDP

In Turkey, R&D expenditures are financed by the public sector, the private sector and the higher education sector. When looking at public and private sector shares, which are financial resources within R&D funds; even though Turkey fell behind the EU countries in 2008 with its 31.6% share of the public sector in R&D funding, it was placed above the EU countries in 2003-2007 period. In 2008, the private sector's share in R&D funding was 47.3%, which is lower than the EU countries. It is seen that the share of the higher education sector in the R&D funding in Turkey was 16.2% in 2008 and that outpaced the EU countries where this ratio was 0.9%. 50.9% of R&D expenditures are financed by the private sector in 2015, followed by the public sector with 26.3%, the higher education sector with 18.4%, other domestic resources with 3.4% and foreign resources with 1.1%. (TURKSTAT, Turkish Statistical Institute, 2016).

Table I: R&D Expenditure by Sector and Expenditure Group

Years	Commercial	Public	Higher Education	Total R&D Expenditures	Staff Expenditures	Other Expenditures
2008	3.048.503.098	823.650.071	3.020.895.031	6.893.048.199	3.245.282.852	3.647.765.348
2009	3.235.272.345	1.016.522.342	3.835.657.913	8.087.452.600	4.004.846.364	4.082.606.236
2010	3.942.908.434	1.060.683.036	4.263.998.147	9.267.589.617	4.756.600.202	4.510.989.415
2011	4.817.272.485	1.263.503.530	5.073.373.782	11.154.149.79	5.726.332.115	5.427.817.683
2012	5.891.214.749	1.436.923.417	5.734.125.228	13.062.263.39	6.892.626.906	6.169.636.489
2013	7.031.518.974	1.543.493.558	6.232.309.394	14.807.321.92	7.996.726.569	6.810.595.351
2014	8.760.019.770	1.705.399.800	7.132.697.872	17.598.117.44	9.219.848.997	8.378.268.443
2015	9.435.675.907	1.803.652.239	7.853.622.737	18.425.035.728	9.985.932.126	8.907.532.724

Source: Turkstat, 2016.

When the R&D expenditure according to sector and expenditure group in Turkey shown in Table 2 is compared to the previous years, there is a growth and development. According to the TURKSTAT data, which evaluates the years between 2008 and 2015, it is seen that the highest expenditure is in 2015. It is possible to see the importance given to R&D by looking at the R&D expenditure figures. When the R&D expenditures of the private sector and the public sector in Turkey are compared, the expenditure that the private sector has made is to a very serious extent compared to the public expenditure. The expenditures made on R&D staff shows the great emphasis that Turkey has placed on the issue over the years. Turkey is targeting that the share of companies' R&D expenditures in GDP to be 2%, in 2023. R&D expenditures both increase the competitiveness

of a country and are very crucial as an indicator of the economic development. Looking at the competitive strength rankings in the "Global Competitiveness Index" 2015-2016 report by the World Economic Forum (WEF); Switzerland takes the lead, followed by Singapore and the United States. The countries that continued the top 10 rankings are Germany, Netherlands, Japan, Hong Kong, Finland, Sweden, and England. The countries that support R&D and innovation are those that are at the highest level according to this report.

Looking in terms of Turkey; although Turkey has risen by 16 rows with significant improvements in performance according to the 2012-2013 Global Competitiveness Index, it is seen that it ranks 44th among 148 countries in the 2013-2014 report and 45th among 144 countries in the 2014-2015 report. The fact that the competitiveness score of Turkey declined in the 2015-2016 report was determined to have originated from the deterioration of the macroeconomic environment.

Table II: Some Countries' Global Competitiveness Index (GCI) Rankings

		GCI 2015-2016		**GCI 2014-2015**	
Economy	**Rank**	**Value**	**Rank**	**Value**	**Change**
Switzerland	1	5,76	1	5,70	-
Singapore	2	5,68	2	5,65	-
United States	3	5,61	3	5,54	-
Germany	4	5,53	5	5,49	1
Netherlands	5	5,50	8	5,45	3
Japan	6	5,47	6	5,47	-
Hong Kong SAR	7	5,46	7	5,46	-
Finland	8	5,45	4	5,50	-4
Sweden	9	5,43	10	5.41	1
United Kingdom	10	5,43	9	5,41	-1
Qatar	14	5,30	16	5,24	2
France	22	5,13	23	5,08	1
Australia	23	5,15	21	5,16	-2
Saudi Arabia	25	5,07	24	5,33	-1
Korea, Rep.	26	4,99	26	4,96	-
China	28	4,89	28	5,25	-
Spain	33	4,59	35	4,55	2
Chile	35	4,58	33	4,60	-2
Portugal	38	4,52	36	4,54	-2
Italy	43	4,46	49	4,42	6
Russian Federation	45	4,44	53	4,37	8
South Africa	49	4,39	56	4,35	7
Turkey	**51**	**4,37**	**45**	**4,46**	**-6**
Bulgaria	54	4,32	54	4,37	-
India	55	4,31	71	4,21	16
Mexico	57	4,29	61	4,27	4
Iran, Islamic Rep.	74	4,09	83	4,03	9
Brazil	75	4,08	57	4,34	-18
Greece	81	4,02	81	4,04	-
Algeria	87	3,97	79	4,08	-8

Source: World Economic Forum, the Global Competitiveness Report 2014-2015, 2015-2016

IV. EMPIRICAL ANALYSIS

In the study, the regression model was analysed for the period of 1998-2015, intended for determining the impact of R&D expenditures on development. Development (HDI) was considered as dependent variable and R&D expenditures (R&D) as independent variable. The inadequacy of measuring the development only by economic growth has led to the creation of people-centred measurement techniques. In this context, the HDI, developed by the UNDP in the light of scientific studies, gives a summarized measurement of human development and provides the comparison of countries within themselves and with other countries. HDI is calculated on the basis of three basic components: health, knowledge and income level. These elements are the basic elements of a good life and access to economic resources, and they also play a key role in the realization of a large number of political and social elements. Calculated for the first time in 1990 and published annually, HDI has been developed in the course of time and was finalized in 1999.

Table III: HDI Data for Turkey

Years	HDI
1998	0.73
1999	0.74
2000	0.75
2001	0.73
2002	0.75
2003	0.78
2004	0.79
2005	0.80
2006	0.80
2007	0.70
2008	0.71
2009	0.69
2010	0.70
2011	0.70
2012	0.72
2013	0.76
2014	0.76
2015	0.76

Source: UNDP, Human Development Reports, 2016
In the regression analysis, solutions were performed under the Newey-West algorithm.

Table IV: Regression Model Estimation Results

Dependent Variable: HDI
Method: Least Squares
Sample: 1998 2015
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
R&D	0.069499	0.020036	3.468671	0.0009*
C	4.05E+08	56969746	7.110111	0.0000

R-squared	0.418777	Mean dependent var	3.26E+08
Adjusted R-squared	0.414127	S.D. dependent var	2.65E+08
S.E. of regression	2.35E+08	Akaike info criterion	41.39933
Sum squared resid	9.27E+18	Schwarz criterion	41.43622
Log likelihood	-3516.943	Hannan-Quinn criter.	41.41430
F-statistic	47.04754	Durbin-Watson stat	1.948134
Prob(F-statistic)	0.000000	Wald F-statistic	3.522914
Prob(Wald F-statistic)	0.062260		

*Significant at 0.05 level

The independent variable R&D in hand, explains 41.8% of the dependent variable HDI. That is, the R&D alone contributes 41.8% to the HDI variable. As the F test showing the model's significance was $p<0.05$, the H1 hypothesis indicating that the model was significant was accepted. If the R&D variance increases by 1%, the HDI variant will increase by 6%. Positive statistically significant effect of R&D variable on development was determined. For the test of the assumptions of the obtained model, Jarque-Bera (JB) which is the normal distribution test of error margins was applied first.

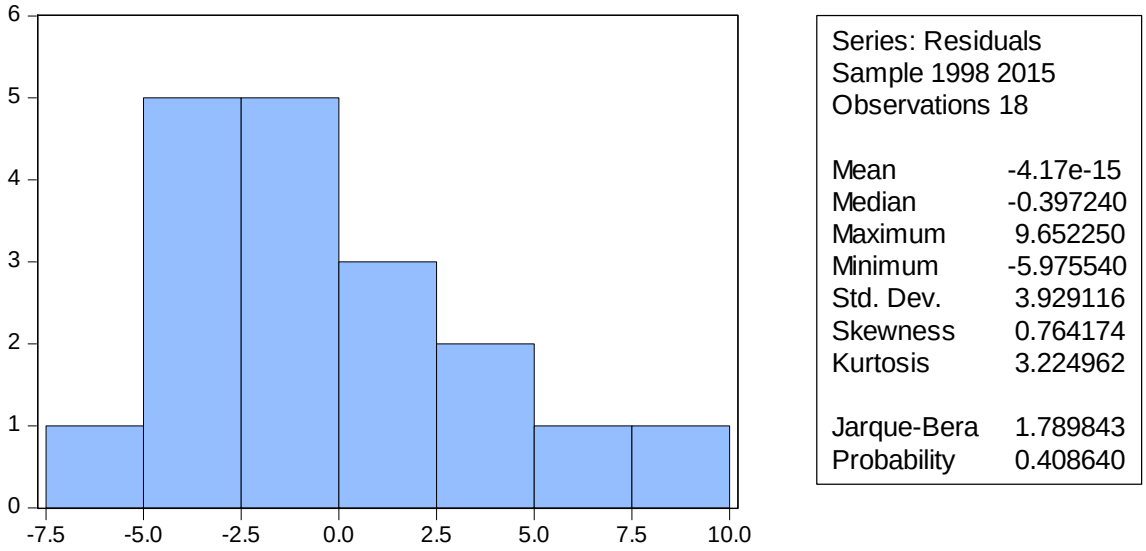

Figure 2: Jarque-Bera Normality Test Results

As can be seen from the results, since p>0.05, the Ho hypothesis, which indicates the normal distribution, is accepted. The LM test was applied for testing the serial correlation of error margins (autocorrelation).

Table V: Breusch-Godfrey Serial Correlation LM Test Results

F-statistic	1.245263	Prob. F(2,14)	0.1262
Obs*R-squared	2.795282	Prob. Chi-Square(2)	0.1235

As p>0.05 in the test results, Ho hypothesis, which indicates no autocorrelation, is accepted. The Harvey test was applied to determine whether the error margin variances are constant.

Table VI: Heteroskedasticity Test: Harvey Results

F-statistic	2.234526	Prob. F(1,16)	0.1544
Obs*R-squared	2.205787	Prob. Chi-Square(1)	0.1375
Scaled explained SS	2.461880	Prob. Chi-Square(1)	0.1166

As shown in Table 6, as p>0.05, the Ho hypothesis, which indicates homoscedasticity, is accepted. The CUSUM test was applied for the analysis of the structural breaks. As Figure 1 shows, the graph is within confidence limits, with no structural breaks.

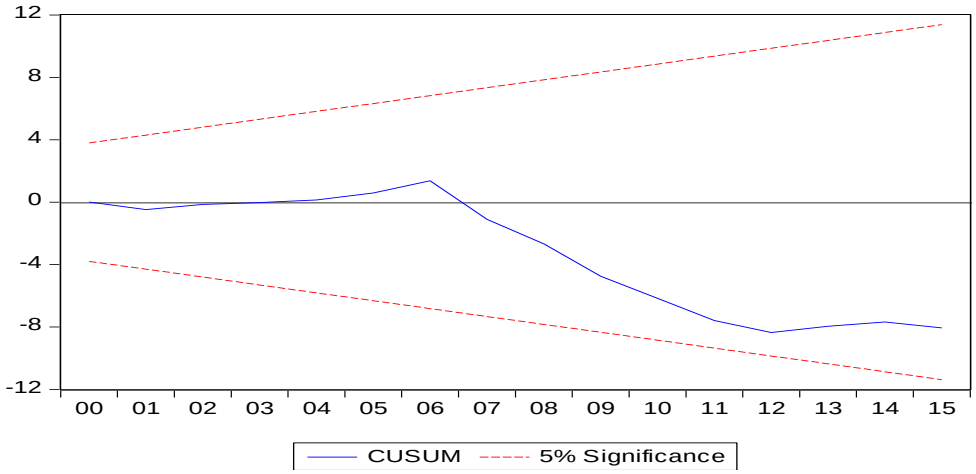

Figure 3: CUSUM Test Results

The analysed regression equation ensured all the assumptions, and the extrapolation of the results obtained is safe.

V. CONCLUSION

As the determining role of science and technology in the economic development process increase day by day; depending on this framework, in general, all countries seem to be in an intensifying search centred on the science and technology policy. An important reason for this is the extraordinary proliferation in the database of technical information, while another crucial reason is the pursuit to increasing the international competitiveness. Scientific and technological advances, which are among the main factors determining the competitive advantages of the nations in the rapidly globalizing world economy, are not left to their own dynamics, and the countries' conscious efforts and policy development pursuits get intense. The science and technology policies and strategies observed in various countries might show differences according to their previous know-how in that field, their socio-economic conditions, and competitive advantages along with their state traditions and functioning.

Developing countries like Turkey should develop opportunities to produce technology within the framework of a science and technology policy to be established while developing new mechanisms for the strengthening and structuring of research fundamentals in order to be able to compete internationally. Above all, the share allocated to R&D from GDP must be increased to 2 percent, the minimum level of being a developed country and it must be ensured that this budget is transferred to the right resources such as the development of high-added-value products and technologies that are competitive on a world scale. First of all, starting with the establishment of mechanisms for more effective and efficient use of existing R&D resources, necessary steps should be taken to develop and implement technology in the priority areas within the framework of university-industry collaboration. Although R&D activities have made progress in proportion to the past years, when compared to other developed and developing countries in the same time frame, the reasons for not developing sufficiently are; the fact that companies and institutions in Turkey still have not reached R&D consciousness, distribution mindset is widespread instead of production, and errors in R&D management.

As the result of the regression equation analysed for the years 1998-2015 with the purpose of determining the effect of R&D variable on development for Turkey, it was determined that if the R&D variable is increased by 1%, the HDI variable will increase by 6%. Positive statistically significant effect of the R&D variable on development was obtained. The share of R&D expenditure in GDP in Turkey is at a level of 1%. Turkey needs to take serious steps in R&D. Investments in R&D and innovation in Turkey fail to be inadequate. Considering the development of emerging markets, countries that achieved great progress should be taken as examples and R&D and innovation exchanges should be enhanced. Relationships with the emerging markets should be improved and should be supported by the large companies. Markets must be constantly monitored and controlled, and new products and services must be located in the emerging markets. Giant companies should develop large R&D and innovation systems and should be provided with the necessary incentives by their states. Hence, the university and the industry should be brought together, and the efficient and effective activities by the university faculty members and industrialists should be supported. In order for new investment areas to be opened and talented individuals to be employed in these areas, it is necessary to increase the emphasis given to training. Long-term targets for R&D and innovation must be identified and sustainable policies must be implemented to achieve these goals. Emerging markets will be able to make a difference in the global competition by means of R&D and innovation and they will be able to catch a high level of prosperity.

In order for the R & D activities to achieve a positive national externality, first of all the deficiencies in this area should be eliminated in the companies. Additionally, companies that take support from the funding sources other than their own resources must use these supports in effective R&D activities. Presenting existing production and engineering activities as R&D activities to cover the expenses, or trying to provide support for the projects without high income, do not contribute to the growth and development of the national economy; it does not provide any benefit to the productivity growth or boosting the competitive power, but also leads to the use of resources in inactive areas.

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